ESRIN EEOS Workshop on Data User Service Requirements - Panel 2,
Frascati, Italy, 13 -15 December 1994

EARTH OBSERVATION DATA SERVICES FOR USERS - AN AUSTRIAN PERSPECTIVE

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ABSTRACT

In order for Remote Sensing, in particular from orbital platforms, to fulfill its promise in a small, land-locked country like Austria, it must become relevant to small regions and rural areas; these are the elements that dominate the highly decentralized Austrian scene.
Users in this case are persons with responsibility over an aspect of a small land area; they operate well-established current data sources.

A successful user service therefore must be scaled by the needs of these users.
We propose that data become available as a finished product for easy assimilation into a routine application at the user's desktop computer. Therefore higher level products and only geographically relevant data are needed for this case. If responsibility exists over only a district, then only district data should be made available. A set of information products needs therefore to be defined for use in these regional and local applications. Remote Sensing from space offers the advantage of regular repeat coverage of an area. This advantage must be brought to bear.

In this paper we first describe the current state of remote sensing and its applications in Austria. Then we sketch a desirable user service that would be relevant for Austria through an offer of subscriptions to information and its changes.

1. BACKGROUND

Remote Sensing developed an identity in Austria in the late 1970's with the creation of a group for Satellite Cartography at the Austrian Academy of Sciences and with the forming of an Institute for Image Processing and Computer Graphics at the Research Center Graz (*Leberl, 1984*). This forceful beginning was followed by a series of cooperative applications and research projects. Two practical applications were country-wide inventories to assess the state of vineyards and for studying damages to forests (see 2.1); typically they were carried out solely based on CIR aerial photography. A more general research-project, covering and sponsoring various activities at the universities was the "Forschungsschwerpunkt Fernerkundung" from 1985 to 1991 (*Kraus et al., 1991*).
Under a Russian-Austrian cooperation, in 1991 an Astronaut was sent into orbit (project "AUSTROMIR"). Within the framework of scientific experiments at this occasion, also the remote sensing experiment FEM was carried out, and focused on geocoding, radiometry and land use studies (*Kalliany, 1992; Kalliany et al., 1992*).

However, this beginning was not followed by ongoing development. Currently the funding for remote sensing activities in Austria has gone to an all-time low (*Leberl and Kalliany, 1995*). A serious objection to satellite remote sensing is the large pixel size at 10 to 30 meters diameter, which is too large to make sense over Austrian territory for national or regional applications. Inventories for practical applications are performed using aerial photography, where a single house or tree as well as most parcel-boundaries may be addressed. It is no surprise then to find the recent Russian KFA-1000, KFA-3000 or KWR-1000 often to be considered the only useful space imagery in Austria;
this imagery has geometric resolutions in the range of 2 to 5 meters.

Using high-resolution photographic imagery requires only fairly conventional skills in visual image-interpretation and (if geometric information has to be obtained) photogrammetry. There also exists a lack of experiences in the community in Austria with the vast range of Earth observation technologies based on digital sensors, with the only exception of the observation of snow and ice. In fact, research in this area has developed to a leading international standard, as exemplified by studies at the University of Innsbruck (*Rott and Nagler, 1993*). One phenomenon in the application of remote sensing is the absence of global research participation. The prevailing mood in the community is that remote sensing must prove itself within Austria, or it will be disqualified from further consideration.

We will therefore develop a sketch of a user scenario for remote sensing for application in Austria. We hope to show that an opportunity exists to build a valid remote sensing activity in Austria.

2. CHARACTERISTIC PAST REMOTE SENSING PROJECTS IN AUSTRIA

We briefly describe three of the most important and very typical remote sensing projects and efforts carried out in Austria within the past years. This should show that high resolution is a basic requirement, but also that the integrated use of different sensors is a prerequisite for some of the potential applications.

2.1 A Countrywide Forest-Damage-Inventory

After some years of developing and testing methodology, this project started in 1989.
It used aerial CIR-photographs at a scale of 1:15,000 with 60% stereoscopic overlap.
The photographic scale was the smallest at which one may still address and rate the single crowns of trees. The methodology required that every 500m a sample of trees had to be classified with respect to the vitality of every single crown. Since this was accomplished in an analytical photogrammetric plotter, exact coordination could be assigned to each tree. The initial plan was to observe the same trees every five years (*Mansberger et al, 1991*).

Because large parts of Austria are covered with wood, nearly half of the country had to be imaged, requiring up to 10,000 photos. There were also constraints on image acquisition: The imagery was to be taken only from May to August and the sun had to be high enough to avoid long shadows. Of course, also weather-conditions had to be good - without clouds and only limited haze in the atmosphere. Due to those constraints, the task of imaging such a large area could not be fulfilled totally (employing three aircraft over two years !). The large cost of image-acquisition and -exploration, has caused funding problems; therefore stage two of this investigation will be performed only for some specific sites.

2.2 Inventory of Waste-Disposal-Sites

A pilot-study (*Zirm et al, 1987*) could show that the locations of possible buried waste-disposals (in most cases being former gravel-pits) may be assessed by reviewing historic aerial photographs which are available in Austria since 1950 at intervals of at least every ten years. Following the experiences of the pilot study, similar investigations have been performed in various parts of Austria affected by the problem of unknown waste-disposality possibly threatening the groundwater. Of course it would be beneficial to continue those inventories with regular up-to-date information which is showing immediately when a new pit is opened or an old one is being filled. The latter would represent a "red flag" for a local officer to investigate those sites.

2.3 Observation of Snow- and Icecover, Especially in Mountainous Terrain

Work is being done on an experimental basis by Innsbruck University to analyze SAR-images and calibrate them with reference-measurements from a field-portable microwave-radiometer. The application is to predict at any time the actual snow coverage and to assess its water content for managing the numerous hydro-power-stations in Austria. This is hoped to support the current dense network of ground-observation-stations of snow. The use of continuous updated satellite imagery would offer the advantage of more detailed information in between the groundstations. However, the fusion of imagery from SAR or other sensors with information from different services are not yet fully developed.

3. PROVIDERS OF REMOTE SENSING IN AUSTRIA

Table 1 represents a summary of most user-oriented activities in remote sensing in Austria. These include providers of basic remote sensing data, value added products and services. Since we restrict the term "remote sensing" to spaceborne imagery, in Table 1 we do not consider activities in the field of photogrammetry, photo-interpretation and mapping from aerial photographs.

The third column in Table 1 is giving a rough estimate of the number of academic staff involved in user-services according to the topics mentioned in 2nd column; staff working on general administration or scientific projects was not considered (see also Table 1 in *Leberl and Kalliany, 1995*)

Nearly all applications mentioned in our survey are either research-projects, or studies performed by or under contract for ministries or provincial governments. Most of them represent research & development expenditures and often also are meant to demonstrate the innovative attitude of the customers. Only very seldom do such studies have a real impact in decision-making processes; instead they merely serve to support already formed opinions. Due to a lack of relevant administrative structures, conclusions from such projects nearly never actually are forwarded to district-level-offices.

On the other hand, Table 1 also presents evidence that there exists remote sensing expertise in Austria, which should be upgraded and integrated in networks of national and international cooperation.

Institution, Department	Services	Personnel
Joanneum Research, Graz Image Processing	Geocoding optical and SAR data, Classification, Application Studies	4.00
Agricultural University, Wien Surveying and Remote Sensing	Rural classification, Forestry, Radiometric correction (optical)	0.50
Austr.Research Center Seibersdorf Environmental Planning	Land use classification, GIS-relevant information analysis	0.75
Technical University Vienna Photogrammetry & Remote Sensing	Geocoding of optical data, Land use classification	1.25
Technical University Graz, Photogrammetry & Cartography	High Mountain Cartography (using high resolution imagery)	0.50
Technical University Graz, Computergraphics	Processing Synergetic Data, Network Server for large Datasets	0.25
Klagenfurt University Geography	Satellite Image-Maps, Land-use interpretation & GIS	0.50
Academy of Sciences, Vienna Cartography	Classification for assessing High Mountain ecosystems	0.50
Austrian Space Agency, Vienna	Distribution of Landsat Data	0.10
Zwittkovits Inc., Wiener Neustadt	Posters from Russian Imagery	0.50
Gepard Inc., Vienna	Parallel Computing Architectures	3.00
Geospace Inc., Bad Ischl	Image-atlases & posters, vendor for various kinds of imagery	4.00

Table 1: Austrian institutions providing remote sensing data, products and services in 1993/94

4. CONCEPT FOR USER SERVICES IN AUSTRIA

4.1 The Political District as a Driving Factor

The whole of Austria has more than districts (400 to 2,000 km² each) and larger cities, with more than 20,000 inhabitants (Figure 1). These local bodies have a considerable responsibility for managing the land, especially in the field of agriculture, forestry and regional planning. Districts are organized into 9 independent states or federal provinces. Provinces have their own elected parliament with legislative power for most issues in agriculture and forestry, regional planning, health and environment as well as other topics like education and culture. The provincial government has the relevant administrational bodies to cope with these tasks and to advise and supervise the district-offices. Of course, the federal government in Vienna also holds some administrative responsibility over Earth and land issues. It is especially at this level that additional funds for inventories, investigations and sponsorship of specific activities can be made available.

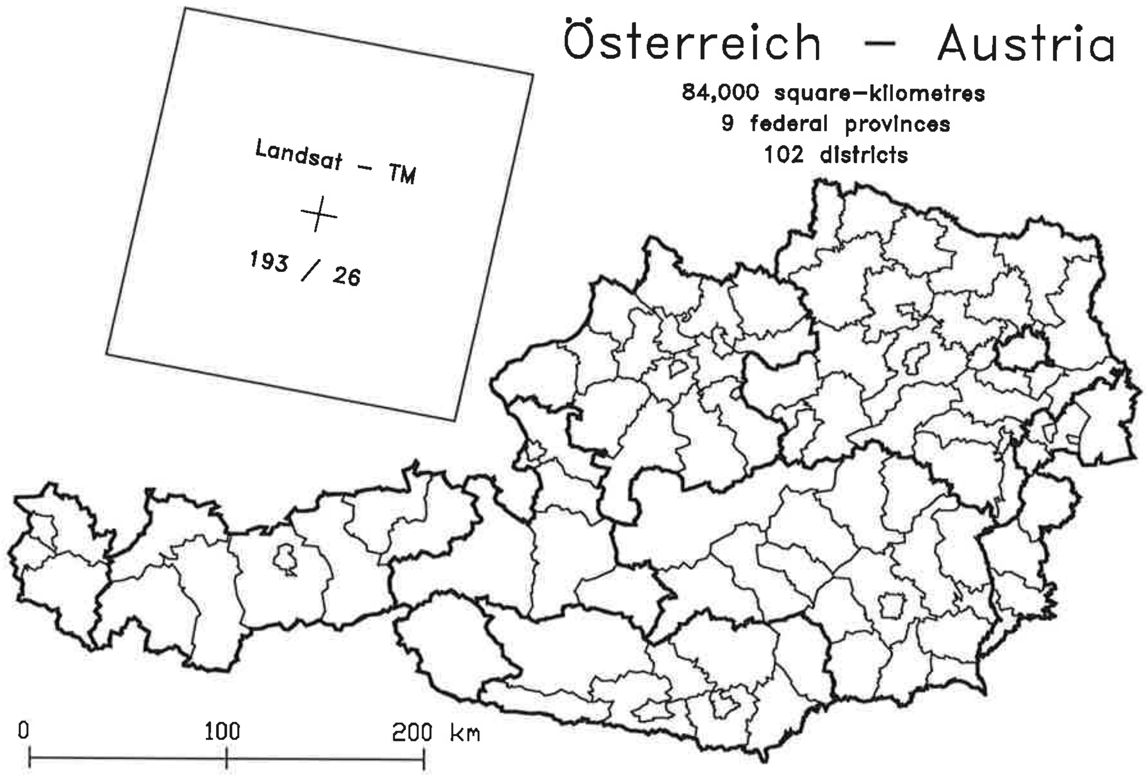

Figure 1: Austria is split into 9 provinces and more than 100 districts. For estimating the relevant areas, the coverage of a full TM-scene (180 x 180 km) is shown as well.

We submit the premise that in Austria remote sensing can be useful from an applications point of view only if it solves issues at the level of districts. If it were to accomplish that then the applications at the higher levels of responsibility would be a matter of course. If remote sensing were not applicable at this district level, then it may not evolve to any significant level of interest in the country and funding for projects will not evolve.

Dataset	Characteristics	Updates
Topographic map	1:50,000 (or enlarged 1:25,000), also in digital raster-format	every 8 years
Regional development plan	1:10,000 (for every community)	edited once; updates on occasion
Cadastral map	1:1,000 to 1:5,600 (partially in digital form)	about 2-3 years
Parcel-inventory "Grundbuch"	computer-based, online	frequently updated
Statistical demographic data	printed compendium	every 10 years
Agro-statistical data	by local agricultural chamber	annually

Table 2: Primary data products at the district level

We believe that the "user" is at a district office, be it for the general administration, or for agriculture, forestry or for environmental protection issues. We expect that some typical and often-used tools at district level would be those listed in Table 2. Currently, for decision-making purposes, some offices may acquire (more or less elaborate) additional data from central agencies (Table 3).

Dataset	Characteristics	Updates
Orthophoto-Map	1:10,000 (not always available)	up to 10 years
Aerial photographs	Copies of Black & White or CIR at 1:5,000 to 1:30,000	for 1:30,000 at least every 10 years
Geological maps	1:50,000	edited only once
Soil-maps	1:25,000	edited only once
Printouts from the GIS maintained at provincal level	corresponding mid-scale (1:100,000 to 1:200,000)	irregular, on occasion

Table 3: Some additional (secondary) data products for district level offices

Satellite imagery would currently be available to local administrations only with very much effort (and therefore will not reach interested citizens): If by chance the relevant section at a provincial government has acquired such imagery as a supplement to their GIS, then it may get forwarded on request to a local district-office. But such imagery in most cases will date back some years and, because local district-offices currently are not equipped for image-processing, the data would be forwarded in analogous form, e.g. as a low-quality paper-print.

4.2 A Specification

A local office needs tools that are easy to operate for people not specialized in remote sensing. We believe that local offices will accept remote sensing data if they are:

- easily and routinely available,
- holding information that occasionally provides for great value,
- of predictable quality, resolution,
- taken at the right time and
- inexpensive.

Currently, remote sensing is none of the above. It is not routinely available, almost never contains relevant new information, nearly always is taken at the wrong time and by no means can be addressed inexpensively.

The paradigm for future remote sensing data transfers can be modeled after the newspaper habits we all have: we throw the old newspaper away and wait for a new issue the next day. Old newspapers are merely kept for historical reference. The continuous updated use of remote sensing data can be viewed in a similar manner.

4.3 Scenario for Data Services

The next regular update of computing- and communications-hardware at the level of district-offices presumably lead to graphic workstations, connected to the emerging high-performance data-networks. Because of increasing capabilities of even low-priced equipment, all prerequisites are available to link the equipment into the Center for Earth Observation CEO, the remote sensing data network currently planned by DG-XII of the European Union. CEO is expected to provide various remote sensing data as they are being produced by orbiting satellites, as well as photographic imagery which is to be digitized as soon as it is acquired.

Needless to mention, the diversity of data will have to be geocoded before being distributed to users at the local level (Table 4). However, such a demand is much easier to define than to satisfy. We believe that a CEO must cope with that requirement. Based on already existing terrain models, good knowledge of the satellite-orbit and software for automatic recognition of control-features, or by matching with already rectified imagery, geocoding should become a routine-task. This work must be split among a certain number of processing-centers; careful planning and regular quality-control will be necessary.

Geocoding will be needed to unlock the main benefit of CEO: The synergetic exploration of data at various resolutions and with spectral diversity. That is also why - even for a 1000 km² district - we propose the use of images of mid- or low-resolution. We expect that if high-resolution imagery with pixels of 1m to 5m is at hand, the user will also want to employ images of reduced resolution or with different radiometric properties. For instance, a local office may want to track the frequently updated AVHRR-coverage by NOAA-satellites to check the development of crops if (and only if !) one can superimpose this material with high-resolution images showing the relevant field-patterns. Because all data would be co-registered to the same geometric reference, one will be able to spot what is "really" behind a particular low-resolution-pixel.

Sensor / Source	Characteristics	Resolution	Repetition
KFA-1000,KFA-3000,KWR-1000	Photographic/Optical	1-5 m	irregular
SPOT / panchromatic	Scanner/Optical	10 m	~ 5 days
SPOT/XS	Scanner/Optical	20 m	~ 5 days
Landsat/TM	Scanner/Optical	30 m	16 days
NOAA /AVHRR	Scanner/Optical	1 km	twice a day
ERS, JERS	SAR	25 m	~ 20 days
Digitized Orthophotography	Optical	0.5 m	~ 8 years
Digital Elevation Models (DEM)	Photogrammetry, Maps	50 m	long-term
Digital Cadastral Map	Field Surveys	50 to 0.1 m	~ 3 years
Local GIS-databases	Various Sources	various	arbitrary
Value-added products	Remote Sensing Data	various	on demand

Table 4: Examples of Data with Relevance for an Austrian CEO-Work environment. Data in the upper part of the table have to be provided regularly by subscription service; others are acquired by the users from other sources, according to their requirements.

Geocoding will support the positioning of specific phenomena which are apparent in one image but not in others; and it will help fieldwork. Relevance may develop for detecting soil-moisture by microwave-data and to monitor crops using high-repetition/low-resolution optical data. Additionally, geocoded data can be referred to other land-related databases like land-use-plans, soil-maps or the cadastre linked to the on-line real estate register. An office may address on the spot the owner of each site; a possibility which is essential at the local level if concrete action is more important than a general statistical evaluation.

While we have great hopes for the use of synergetic data, we are concerned that so much still is unknown. Considerable research is still to be done to develop the synergetic use of remote sensing data.

4.4 Data Quantities

The diversity of data of Table 4, requires a network to collect, process, archive and forward the relevant data products to the users. An office at the provincial level may expect data once a week and tailor them to the needs of the districts. At a desktop-terminal, an officer may operate the software to visually display, merge and render the data in various combinations.

Table 5 presents the amount of data for each of the at present most important sensors. Neglecting 1m-imagery (which we suppose being acquired only once a year) the annual coverage is 111 kB per square-kilometer. For a district of 30 by 30 km² this would make 100 MByte per year, or an average of 2 MByte of data to be forwarded every week. The high-resolution image included, the annual amount increases by a factor of 10 to 1 GByte.

Sensor	Pixelsize	Bands	kByte / km²	scenes / year	kByte / year
KFA-3000	1 m	1	1,000	1	1,000
SPOT-P	10 m	1	10.0	3	30
SPOT-XS	20 m	3	7.5	2	15
Landsat-TM	30 m	7	7.8	6	47
ERS	25 m	1	1.6	12	19

Table 5: Amount of data per square-kilometer from them most important sensors. Acquisitions per year are estimated (see also *Leberl F. and Haselbacher, 1994*).

5. COSTS OF THE SERVICES

An early CEO-study concluded that Europe may have 10,000 potential users of remote sensing data (*NRSC, 1993*). This would place Austria in a range of 2% of this total, at 200 users. A subscription for basic data services, if it were at 1000 ECU per year, would be low enough to entice all potential users to get involved. This cost is granted presumably only feasible if the space and primary segment is financed from the general tax fund. This would be analogous to current funding of aerial surveying data in national programs.

The transfer of remote sensing data should be supported by fast data networks. However, an issue of overwhelming concern is the cost of data network services. Pricing at this time far exceeds the cost per minute for conventional telephone service. We would agree that the cost of transferring data should be a fraction of the cost of data. This would easily be accomplished if ATM were priced per minute at the level of ISDN services (*Leberl and Haselbacher, 1994*).

6. CONCLUSIONS

We argue that a successful future of remote sensing data in a small alpine country like Austria may depend on:

- the ability to develop uses at the level of district offices;
- the availability of high resolution imagery;
- successful geocoding;
- updated data as soon as new images are available;
- augmenting the offering by application-oriented products.

These requirements can be met at reasonable costs only within the framework of a European network; CEO is therefore an important initiative.

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Acknowledgement

Part of this work was funded by the Austrian Ministry of Science and Research, Section II/5.